Basic Co-ordinate/Distance/Area Conversions

[This application is Included in SURPAC "Lite"]

- Carries out various standard Conversions using either built in, or User defined factors.
- Distances, Co-ordinates and/or Areas may be converted.
- For co-ordinate data, transformed Points maybe saved in a Co-ordinate file, or in ASCII file format.

Transforming Gauss Conform to/from Geographical values

[This application is Included in SURPAC "Lite"]

- This set of Transformation programmes supports the following Systems and/or Ellipsoids :-
  - Various Southern African "Lo" Systems using the Clarke 1880 (Modified) Ellipsoid,
  - South African "WG" System using the WGS 84 Ellipsoid,
  - Namibian "Bessel" System using the Bessel 1841 Ellipsoid (GL Metres and Int. Metres),
  - U.K. National Grid System, OSGB36, using the Airy 1830 Ellipsoid,
  - U.K. National GPS Network, ETRS89, using the WGS 84 (GRS80) Ellipsoid,
  - Irish National Grid using the Airy 1830 (Modified) Ellipsoid,
  - Universal Transverse Mercator, U.T.M., using Various Ellipsoids.
- Geographical [Latitude, Longitude] to Transverse Mercator [Y, X] (or [E, N]) transformations
- Transverse Mercator [Y, X] (or [E, N]) to Geographical [Latitude, Longitude] transformations
- Transverse Mercator [Y, X] (or [E, N]) System 1 to System 2 (Belt 1 to Belt 2) transformations
- Transverse Mercator [Y, X] (or [E, N]) System to U.T.M. [E, N] Zone transformations
- U.T.M. [E, N] Zone to Transverse Mercator [Y, X] (or [E, N]) System transformations
- U.T.M. [E, N] Zone 1 to U.T.M. [E, N] Zone 2 transformations

Transform between Airy 1830 and WGS 84 Ellipsoids (U.K.)

View a Sample Screen Display

Ordnance Survey®

OSTN02™ enabled

- This set of Transformation programmes supports the following Systems and/or Ellipsoids :-

    - U.K. National Grid System, OSGB36, using the Airy 1830 Ellipsoid,

    - U.K. National GPS Network, ETRS89, using the WGS 84 (GRS80) Ellipsoid,

    - Universal Transverse Mercator, UTM, using Various Ellipsoids.

- Algorithms and shift data provided by the U.K. Ordnance Survey, and are fully OSTN02 and OSGM02 enabled. In order to use these transformations, however, the files called "OSTN02.DAT" (for Eastings, Northings) and "OSGM02.DAT" (for heights) must exist in the SURPAC application folder. If not, they may be downloaded from the SURPAC Internet site. The following transformations are available :-

    - U.K. National Grid System, OSGB36, to the U.K. National GPS Network, ETRS89

    - U.K. National GPS Network, ETRS89, to the U.K. National Grid System, OSGB36

    - Geographical [Latitude, Longitude] (WGS 84) to to the U.K. National Grid System, OSGB36.

Transform between Clark 1880 (Modified) and WGS 84 Ellipsoids (South Africa)

- This programme provides for rapid and accurate transformations between the Cape Datum (Clarke 1880 Modified Ellipsoid) (either an RSA "Lo" System, or a U.T.M. Zone System) and the Hartebeesthoek94 Datum (WGS 84 Ellipsoid) (either an RSA "WG" System, or a U.T.M. Zone System) within South Africa.

- Two control files are provided that cover the entire country and which contain approximately 38,000 common Control Points.

- To carry out a transformation, it is only necessary to have co-ordinate, or Geographical [Lat, Long], data related to one of the two Ellipsoids, and lying within the geographical boundaries of South Africa. These data may be contained in a SURPAC Co-ordinate file, an ASCII Co-ordinate file, an ASCII [Lat, Long] file or be written data that are to be entered manually.

- The transformation carried out is by using either a Weighted Helmert transformation, or a Standard (non-weighted) Helmert transformation, with a User determined number of common control Points.

- This programme is designed to satisfy the requirements of Land Surveyors, Mine Surveyors

- and Engineering Surveyors requiring high accuracy transformations (< 0.10m) for existing data and for GPS derived data. Because of the large number of common control Points (38,000) the transformations are extremely localized and provide the highest accuracy of transformation possible between the two Ellipsoids.

- Tests have shown that typical Standard Deviations resulting from transformations vary between 0.01m and 0.07m. Accuracies in high density urban areas tend to be higher, due to the larger number of common Points in these areas. This programme should not, therefore, be confused with other programmes that offer only approximate (0.50m – 1.50m) transformations for the purpose of small scale mapping, or non-survey related activities.

- Due to the nature of the re-adjustment of the Hartebeesthoek94 co-ordinates using a transformation based on a table of adjustments, or parameters, for a given area cannot provide the same level of accuracy as that of a Weighted Helmert transformation that uses the 4 or 5 closest common Control Points lying around to the Point being transformed.

- The User selects settings from a number of offered options, namely :-

  - The type of Weighting required (None, Inverse Distance or Inverse Distance Squared)
  - The Search Limit to be used when the programme is requested to search for the nearest group of Stations to the current point. This can range from 5Km to 50Km.
  - The Control Points to use. The User selects the number of the nearest common control Points to be used for each Point to be transformed. This number of selected control Points can vary between 2 and 20.

- Once the "Source File" has been selected, the programme will search for the existence of any associated CAD files such as General Plans, Working Plans, Sectional Title Sheets and CAD Plot files, that may also need to be transformed. If required, any associated CAD file will be transformed, using the same Control files and Options as set for the Co-ordinate file.

- Finally, the programme provides the facility of transforming any other related files such as Tacheometric files, Contour Files, DTM files and Centre Line files. These files, if required, will be transformed using the same Control files and Options as set for the Co-ordinate file.

Locate and Add Nearest Trig. and/or TSM Beacons (South Africa)

- This programme provides the facility of locating a set of the nearest Trigonometrical Beacons and/or Town Survey Marks (TSMs) to a User defined geographical position.

- If required, the located set of Points may be added to the current Co-ordinate File.

- Currently, this programme is limited to the geographical area of the Republic of South Africa, and to surveys defined as using either the "Lo" (Clarke 1880 (Modified) Ellipsoid) System, or the "WG" (WGS 84 Ellipsoid) System (also referred to as the "Cape Datum" and the "Hartebeesthoek94 Datum respectively).

- It is not necessary of the User to define any source file for the location of the Trig. Beacons, or TSMs. SURPAC has two built in Source Files covering the entire geographical area of

South Africa, and data are drawn from these two files

- Each of these Source Files contains the double precision geographical positions (Latitude and Longitude) of about 38,000 Points in the "Lo" (Clarke 1880 (Modified) Ellipsoid) and "WG" (WGS 84 Ellipsoid) respectively.

- This programme will automatically search and extract the "Lo" or "WG" Point information from the appropriate Source File.

- Since these Source File Points are stored in shifted [Lat, Long] format, any Degree Square boundaries become irrelevant to the programme. Surveys can be located close to any Degree Square boundary, and the programme will still generate its own "Degree Square" of Points, centered about the Survey, or any defined Point in the Survey. Data may be drawn from different Degree Squares for any given Survey.

- The programme offers User options for both the selection of Points, and the display mode, namely :-

  - The Search Centre position may be User selected,

  - The located Points may be either Trig. Beacons, TSMs, or both,

  - The number of locate Points displayed may be set according to a required maximum number, or a required maximum search radius,

  - The display of located Points may be in order of Distance, Direction or Point Name,

  - Any of the located Points in the displayed list may be tagged as "not required", to prevent them from being added to the Co-ordinate File,

  - Any located Point in the displayed list may have its Degree Square, Latitude and Longitude shown on a sub-display, for identification purposes,

  - An output of the displayed list of located Points may be made to the Printer, an ASCII file or the Clipboard, and

  - The located Points in the displayed list, marked as "required" (i.e. the ticked Points) may be added to the current Co-ordinate File.

Weighted Helmert Transformations

- This programme is capable of handling any planar, orthogonal System to System transformation.

- The programme uses a Parametric Weighted Least Squares adjustment technique. Developed in-house, this technique uses the rigorous least squares adjustment of residuals determined from the weighted centres of gravity of the two sets of Control Points, for each of the transformed Points. This approach allows for full system to system transformation flexibility.

- The input requirement is a SURPAC "Source" Co-ordinate file, in the "Old System", containing the points to be transformed.

- The User selects settings from a number of offered options, namely :-

  - The type of Weighting required (None, Inverse Distance or Inverse Distance Squared)

  - The Search Limit to be used when the programme is requested to search for the nearest group of Stations to the current point. This can range from 5Km to 500Km.

- The Control Points to use. The User can select any number of control Points (2 or more) from a displayed list of common control Points, or Stations. In this case these selected control Points will be used for each point to be transformed, regardless of their relative positions. Alternatively, the User can instruct the programme to search for the a group of the nearest common control Points for each of the "Source File" points to be transformed. A group of control Points can consist of between 2 and 50 Points.

- Once the "Source File" has been selected, the programme will search for the existence of any associated CAD files such as General Plans, Working Plans, Sectional Title Sheets and CAD Plot files, that may also need to be transformed. If required, any associated CAD file will be transformed, using the same Control files and Options as set for the Co-ordinate file.

- Finally, the programme provides the facility of transforming any other related files such as Tacheometric files, Contour Files, DTM files and Centre Line files. These files, if required, will be transformed using the same Control files and Options as set for the Co-ordinate file.

Standard Helmert Transformations

[This application is Included in SURPAC "Lite"]

- This programme is capable of handling any planar, orthogonal System to System transformation.

- The programme uses a Parametric non-weighted (1st Order) Least Squares adjustment technique. Developed in-house, this technique uses the rigorous least squares adjustment of residuals determined from the weighted centres of gravity of the two sets of Control Points.

- The minimum requirement is two common points co-ordinate in both systems.

- For transformations (or super-positions) with more than two common points, the transforming parameters are determined by the means of a Least Squares best fit.

- The transformation is always carried out <u>from</u> some other system, <u>to</u> the system as defined by the current Co-ordinate File

- The Common Point data from which the transformation is being carried out, may be manually entered, or read from another Co-ordinate File

- There are a number of Options that may be made once a system to system transformation has been made, viz :-

  - You may DELETE a common point, or a number of common points from the transformation and then re-run the transformation.

  - You may ADD a further common point, or a number of further common points, to the transformation and then re-run the transformation.

  - You may EDIT any point in the transformation by re-entering its co-ordinates and then re run the transformation.

- The transforming parameters of a previous transformation may be entered directly to allow immediate transformation of non-common points. These values may be entered manually, or read from an ASCII file. This file may be re-generated immediately after carrying out a transformation.

- Once correct, the transformation of non-common points may be carried out. These

transformed points may be stored in the current Co-ordinate file.

2nd Order Polynomial (Affine) Transformations

- This programme is capable of handling any planar, orthogonal System to System transformation, using a polynomial (2nd order) orthogonal transformation.
- The minimum requirement is three common control Points in the two Systems.

  For transformations (or super-positions) with more than three common points, the transforming parameters are determined by the means of a Least Squares best fit.
- The transformation is always carried out <u>from</u> some other system, <u>to</u> the system as defined by the current Co-ordinate File
- The Common Point data from which the transformation is being carried out, may be manually entered, or read from another Co-ordinate File
- There are a number of Options that may be made once a system to system transformation has been made, viz :-
  - You may DELETE a common point, or a number of common points from the transformation and then re-run the transformation.
  - You may ADD a further common point, or a number of further common points, to the transformation and then re-run the transformation.
  - You may EDIT any point in the transformation by re-entering its co-ordinates and then re run the transformation.
- The Transformation of non-common points may be carried out. These transformed points may be stored on the current Co-ordinate file.

GoldFields To/From Gauss Conform ("Lo" or "WG") Transformations   (South Africa)

- This set of programmes allows for the transformation of a Point, or a block of Points, from any one of the Goldfield Systems, to the appropriate Gauss Conform "Lo" (Clarke 1880 (Modified) Ellipsoid) System, or to the "WG" (WGS 84 Ellipsoid) System (also referred to as the "Cape Datum" and the "Hartebeesthoek94 Datum respectively) Systems, and vice versa.
- These transformations are applicable to both the Clarke 1880 (Modified) and the WGS1984 Spheroids, and apply to the South African Witwatersrand Gold mining areas.
- The programmes obviate the need to use any tables for the determination of interpolating parameters, as all the necessary transforming parameters are resident in the software.
- These transforming parameters were derived by means of a series of second order (Affine) Polynomial Transformations. Adjustment of the polynomial constants was by the method of Least Squares. Samples of between 13 and 21 common points were used in each of the 5 transformations involved. The sampled points were selected to give a reasonable coverage

of each system.

Naturally, the system to system fits were not perfect due to survey differences in the respective systems. The following figures provide a basis for estimating the expected accuracy of a point transformed from a GoldFields System to a Gauss Conform System :-

GOLDFIELDS SYSTEM	GAUSS (Lo or WG) SYSTEMS	COMMON POINTS	STANDARD DEVIATION
BOKSBURG	Lo/WG 29°	21	0,09m
HEIDELBURG	Lo/WG 29°	19	0,10m
JOHANNESBURG	Lo/WG 27°	13	0,06m
JOHANNESBURG	Lo/WG 29°	13	0,06m
KRUGERSDORP	Lo/WG 27°	19	0,09m

Display [DY, DX, DZ] Monitoring Data

This programme provides the facility for cyclic, or periodic, monitoring of the [Y, X Z] movement of measured beacons from defined and fixed base Points.

The sets of Point co-ordinates for each of the cyclic measurements are be stored in separate Co-ordinate Files.

As monitoring data are normally required for assessing small movements over time, the Point co-ordinates would typically be determined from Least Squares adjustments of high precision observation sets.

The programme will accept up to 50 sets of cyclic data, with each set being derived from a User defined Co-ordinate File.

The programme determines the list of Common Points by searching through each of the defined Files and selecting those Points that are included in at least two of those Files, with one of the Files being the Base File (the current Co-ordinate File).

From the total list of Common Points, the User may select up to 200 Points that are to monitored for the current calculation and display.

The programme will calculate and display data by Point Name, in alphabetical order. For each Point, the File Name, Date of Survey, co-ordinate values, co-ordinate differences from the values held in the Base File, will be displayed on an A4 sheet.

To the right of each Point display will be drawn a Point Cyclic Movement Graph which shows the File by File movement of the three positional components ([DY, DX, DZ] or [DE, DN, DH]). This provides a visual inspection of the Point movement which is often simpler and quicker to analyze than scanning through columns of data.

The Point Cyclic Movement Graphs are always shown in millimeters, and their scale depends on the absolute maximum movement recorded for any of the Points monitored.

After completing a monitoring calculation and display, the programme will store all the selected File Names and defined sheet Headings into an ASCII File.

This ASCII File is automatically used by the programme to load up the File Names and Headings as default entries, the next time a monitoring calculation is run from this same co-ordinate File. These default values may be modified, or extended, as required.

Locate and Mean Point Groups in a Co-ordinate File

[This application is Included in SURPAC "Lite"]

- A Point Group is defined as two, or more, Points in a Co-ordinate File that lie within a prescribed distance of one another. The programme will search through the current Co-ordinate File, using an alphanumeric order, looking for Points that create a Point Group. A Point Group can consist of between 2 to 14 Points in size.

- This programme incorporates a number of useful functions. For example :-

    - It may be used to search for and Display the Values of a Point that may have been surveyed two, or more, times and Saved in the Co-ordinate File under different Names.

    - It may be used to Mean all the Points in a Point Group and then save these meaned value in the Co-ordinate File, using a default Name or a User entered Name.

    - It may be used to Adopt either the first, or the second located Point in a Point Group and then save this Point's values in the Co-ordinate File , using a default Name or a User entered Name.

    - It may be used to Delete all Points in a Point Group, other than the Point selected as the required Point representing the Point Group.

Point Comparisons using Different Co-ordinate Files

[This application is Included in SURPAC "Lite"]

- This programme provides the facility of comparing any two SURPAC Co-ordinate Files.

- The displayed programme Screen makes allowance for defining the two required files and for selecting the mode to be used for comparing the two files.

- The Files may be compared by using the Point Names to identify common Points. When a matching Point is found, the programme will compare the co-ordinates of the Point in each of the two Files and calculate the polar values derived from the co-ordinate differences (if any).

- The Files may also be compared by matching co-ordinates . You must set a logical limit within which the programme must search for a matching Point. For each Point in File No.1, the programme will search for the closest Point, within the defined search radius, in File No. 2. When a Point is found, the programme will calculate the polar values derived from the co-ordinate differences of the two Points (if any).